2.2.7.8 Electric Power

Table 2–27 shows DOE's estimate of the power demands at the Moab site and at the three potential off-site disposal locations for the three transportation modes. In general, the major demands would be:

- Field office trailers.
- Office and parking lot security lighting.
- River pump station (at Moab).
- Decontamination water sprays and recycle pumps.
- Train transfer station (rail transportation).
- Pipeline slurry system (pipeline transportation).

Table 2–27. Estimated Maximum Average Annual Electric Power Demand (kVA) For the Off-Site Disposal Alternative

Transportation Mode	Location			
	Moab Site	Klondike Flats Site	Crescent Junction Site	White Mesa Mill Site
Truck	600	300	300	300
Rail	700	600	600	–
Pipeline	–	2,500 (terminal)	2,800 (terminal)	3,100 (terminal)
To Klondike Flats	3,400			4,800 (booster)
To Crescent Junction	4,800			
To White Mesa Mill	6,100			

2.3 Ground Water at the Moab Site

Section 2.3.1 provides background on the ground water standards, contaminants of concern, and the compliance strategy selection process. This includes remediation goals for the ground water, and the relationship with existing interim actions. Section 2.3.2 discusses the proposed ground water remediation, including remediation options and time frames, and the predicted contaminant concentrations as a result of active remediation. It also discusses the predicted outcome of the ground water No Action alternative. Section 2.3.3 discusses ground water remediation uncertainties.

2.3.1 Background

The uppermost aquifer at the Moab site occurs in unconsolidated Quaternary alluvial material deposited on older bedrock units in the basin that forms Moab Valley. Although the quality of this aquifer has been adversely affected by uranium processing activities at the site, it does not represent a potential source of drinking water. However, discharge of contaminated ground water from this aquifer has resulted in elevated concentrations of ammonia and other site-related constituents in the Colorado River. While the contaminants do not pose unacceptable risk to humans, they do exceed levels considered to be protective of aquatic life. Therefore, the objective of the proposed ground water action is to protect the environment, particularly endangered species of fish that are known to use that portion of the river.

Contamination in the ground water at the Moab site is regulated by EPA standards in 40 CFR 192. Moab site remediation must comply with Subpart A standards for ground water protection and Subpart B standards for cleanup of residual ground water contamination. Subpart C provides guidance for implementing methods and procedures to reasonably ensure that standards of Subpart B are met.

DOE's proposed action for ground water cleanup was developed using the framework described in the UMTRA Ground Water Project PEIS (DOE 1996a). This framework uses a stepwise, risk-based approach for selecting a compliance strategy and is based on site-specific characteristics. The following discussion describes the PEIS framework, identifies the overall compliance strategy using this framework, and summarizes the long-term monitoring program. A more detailed description of the PEIS compliance strategy selection process is presented in the *Site Observational Work Plan for the Moab, Utah, Site* (SOWP) (DOE 2003b).

A detailed remedial action plan would be developed following issuance of the ROD and would contain action-specific design information. However, the treatment technologies summarized in this EIS, supported by the results of site characterization studies and ground water flow and transport modeling (DOE 2003b), provide a reasonable range of scope and requirements for ground water actions to meet the requirements of 40 CFR 192. The analyses of these actions in this EIS provide sufficient information for decision-making under NEPA.

2.3.1.1 EPA Ground Water Standards

Ground water remediation actions to meet the EPA standards for inactive uranium-ore processing sites (40 CFR 192) are selected first by determining the appropriate standards for the site, then by identifying a compliance strategy that can meet the standards. Several different ground water standards could apply to the Moab site. These include background concentrations, maximum concentration limits (MCLs) (EPA ground water standards in 40 CFR 192), alternate concentration limits (ACLs), and supplemental standards (see 40 CFR 192 for definitions); applicable standards depend on site-specific cleanup objectives and conditions. Potential strategies for achieving these standards include no remediation, natural flushing with institutional controls, natural flushing with institutional controls in combination with active remediation, and active remediation alone.

At UMTRCA sites, EPA standards must be met in the uppermost aquifer, which is most likely to be affected by uranium-ore processing activities. The uppermost aquifer at the Moab site contains a highly saline (salty) water, often referred to as brine, which can be as thick as 400 ft, overlain with a thin layer of less salty water. Because ground water in the major portion of the uppermost aquifer has a TDS content exceeding 10,000 mg/L, the aquifer meets the definition of a limited-use aquifer as described in EPA's *Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy* (EPA 1988).

Ground Water Compliance Strategies

No remediation means that no ground water remediation is necessary because ground water contaminant concentrations meet acceptable standards. No remediation under the PEIS is not the same as "no action" under NEPA, because actions such as site characterization would be necessary to demonstrate that no remediation is warranted.

Natural Flushing means allowing the natural ground water movement and geochemical processes to decrease contaminant concentrations.

Active Remediation means using active ground water remediation methods such as gradient manipulation, ground water extraction and treatment, or in situ ground water treatment, to restore ground water quality to acceptable levels.

Under the requirements of 40 CFR 192 Subpart C, the uppermost aquifer meets the criteria to apply supplemental standards based on limited-use ground water. Supplemental standards are regulatory standards that may be applied when the concentration of certain constituents (in this case, TDS) exceeds the normally applicable standards (e.g., MCLs; see 40 CFR 192, Subpart C for further explanation) for reasons unrelated to site contamination. The use of supplemental standards must be protective of human health and the environment. Therefore, remediation of the uppermost aquifer to meet ground water or drinking water standards is not required because a limited-use aquifer is not likely to be developed as a public drinking water source. Instead, at sites with limited-use ground water, the supplemental standards require management of contamination due to tailings in a manner that ensures protection of human health and the environment from that contamination. This means that if site-related contamination could cause an adverse effect on a drinking water aquifer or on a connected surface water body, management of contamination would be necessary to protect these resources.

Because no drinking water aquifer is affected by site-related contamination, ground water remediation focuses on protecting surface water resources for beneficial use. Risk calculations show that risks to human health would be very low for all probable uses, even using conservative assumptions (see Appendix D of this EIS). However, contaminant concentrations in surface water exceed aquatic criteria for five site-related constituents. Consequently, the compliance strategy focuses on protecting ecological receptors (i.e., endangered fish) and achieving compliance goals (i.e., surface water standards) in the surface water.

2.3.1.2 Contaminants of Potential Concern

Concentrations of some site-related contaminants in ground water at the Moab site are above appropriate standards or benchmarks for protection of aquatic organisms in surface water. A thorough screening of contaminants is provided in Appendix A2. The screening process identified five contaminants of potential concern: ammonia, copper, manganese, sulfate, and uranium. Modeling of the tailings' long-term seepage indicates that seepage rates will decrease 25-fold from the current rate of approximately 20 gpm (Figure 6−3, Table 6−3 of the SOWP [DOE 2003b]) to the predicted long-term flux of 0.8 gpm. This 25-fold decrease in volumetric and contaminant mass flux from the tailings, coupled with the 10-fold average dilution of ground water observed in surface water concentrations (DOE 2005b), is anticipated to result in decreases in contaminant surface water concentrations to levels below aquatic benchmark values and appropriate water quality standards without any geochemical transformations beyond simple dilution. For example, the maximum detected copper concentrations in surface water adjacent to the site range from 5 to 14 mg/L; while the Utah Water Quality Criterion is 12 mg/L. Similarly, maximum detected manganese concentrations in surface water (up to 11.5 mg/L) exceed the aquatic benchmark value for protection of aquatic organisms of approximately 0.01 mg/L in only five locations, and natural manganese background ground water concentrations of 19 to 38 mg/L have been observed. The maximum detected uranium surface water concentration is 5 mg/L, roughly 100 times the aquatic benchmark of 0.04 mg/L, and the maximum detected sulfate surface water concentration is approximately 14,000 mg/L, roughly 28 times the upper limit of background range (439 mg/L). Therefore, the resulting 250-fold decrease in future surface water concentrations predicted from decreased tailings seepage and ground water dilution through mixing with surface water provide a reasonable assurance that long-term concentrations will be protective of aquatic organisms.

However, ammonia is the key constituent driving the proposed ground water remedial action because of its high concentrations in the tailings seepage and ground water and its toxicity to aquatic organisms (EPA 1999). It is assumed that if ammonia target goals could be achieved that are acceptable for protection of aquatic life, concentrations of the other four contaminants of potential concern would also be protective. Even though the geochemical behavior of the other contaminants of potential concern differs from that of ammonia, it is anticipated that concentrations of these constituents would decrease to protective levels in the same time frame that it would take for ammonia to reach protective levels because their concentrations are less elevated above applicable remediation criteria (e.g., surface water standards), the contaminants are less widespread, or they occur at elevated concentrations less frequently. For this reason, ammonia is the focus of the following discussion.

National ambient water quality criteria (AWQC) for the protection of aquatic life have been established for ammonia (EPA 1999). The State of Utah is in the process of adopting these criteria as state surface water quality standards. AWQC have been identified that are protective of both acute and chronic exposures. Acute criteria vary with pH; chronic criteria are both pH- and temperature-dependent. Chronic aquatic criteria represent the low end of the potential concentration range for protection of aquatic species from ammonia toxicity; the majority of chronic values fall in the range of 0.6 to 1.2 mg/L ammonia (total as N) based on site-specific pH conditions (EPA 1999). Acute criteria represent the higher end of the concentration range; the majority of acute values fall within the range of 3 to 6 mg/L. Therefore, it is DOE's position that concentrations of ammonia (total as N) in surface water in the 0.6- to 6-mg/L range would be fully protective of aquatic life.

If ground water quality met surface water standards, then discharge of ground water to the surface should not result in exceedances of those standards unless some other process (e.g., evaporation) increased contaminant concentrations in surface water. However, establishing the low end of the protective range as the ground water target goal is probably not necessary to achieve compliance with surface water standards. Available data regarding interaction of ground water and surface water indicate that concentrations of most constituents decrease significantly as ground water discharges to and mixes with surface water (a 10-fold decrease is observed on average [DOE 2003b]). In general, more recent data collected by DOE since the SOWP confirm, with a few exceptions, that a 10-

Cleanup Terminology

Ammonia Concentrations—Where concentrations of ammonia are referred to in the text, these are expressed as *total ammonia as nitrogen (N)*. The numbers represent all forms of ammonia (e.g., NH_3, NH_4) converted to reflect only the nitrogen component in them.

Federal Ambient Water Quality Criteria (AWQC) for Ammonia—Numerical concentrations of ammonia (total as N) that are protective of aquatic life in surface water. Chronic exposure concentrations vary with both temperature and pH of the waters. Acute exposure concentrations vary only with pH of the waters. AWQC are only guidelines but can be adopted by states as enforceable standards.

Utah Surface Water Standards—State standards for protection of water quality of surface waters of the state. The standard designates appropriate uses of specific surface water bodies and provides numerical and narrative standards for those designated uses. The State of Utah is in the process of adopting federal AWQC for ammonia as the numerical standards for this constituent.

Remediation Objective—The desired condition that should result when remediation of the site is completed. For the Moab site, the remediation objective would be to meet state surface water quality standards for ammonia (both chronic and acute) in surface water where appropriate. The applicable standard for a given location is dependent on temperature and pH and the presence or absence of a mixing zone, as specified in the state standards.

Target Goal—As used in this document, the target goal for ammonia in ground water is the concentration that DOE has determined would meet the remediation objective in surface water. As explained in the text, meeting a target goal of approximately 3 mg/L ammonia (total as N) in ground water would result in compliance with Utah surface water standards for ammonia in surface water.

fold dilution factor occurs where the ground water plume is discharging adjacent to the river shoreline. In background locations where elevated ammonia from the Paradox Formation is discharging to the surface water, the 10-fold dilution factor may not apply. This more recent calculation set, *Ground Water/Surface Water Interaction for the Moab, Utah, Site* (DOE 2005b), also provides a more detailed evaluation of the transfer mechanism between ground water and backwater areas.

Consequently, there is a reasonable assurance that protective surface water concentrations could be achieved by meeting less conservative goals than chronic standards in ground water. The target goal of 3 mg/L in ground water (the low end of the reasonable acute range) is anticipated to provide adequate surface water protection. The 3-mg/L concentration represents a 2- to 3-order-of-magnitude decrease in the center of the ammonia plume and would be expected to result in a corresponding decrease in surface water. On the basis of sampling data presented in the SOWP (DOE 2003b), it appears that if a concentration of 3 mg/L ammonia could be achieved everywhere in surface water, approximately 99 percent of the locations sampled in the past would comply with the acute criteria, and given the 10-fold dilution factor, the chronic criteria would also be met outside the mixing zone. The 10-fold dilution factor is conservative, and a higher ground water concentration may also achieve compliance with surface water standards, although at a lower confidence level. Coupled with the average 10-fold dilution and the tendency for ammonia to volatilize, 3 mg/L in ground water is anticipated to result in compliance with both acute and chronic ammonia standards in the river adjacent to the site. Therefore, DOE proposes to use the 3-mg/L concentration of ammonia as a target goal for evaluating ground water cleanup options. However, the ultimate remediation objective would still be to meet all applicable ammonia standards in surface water.

2.3.1.3 Compliance Strategy Selection Process

Using the PEIS framework shown in Figure 2–40 and site-specific data collected through site characterization and analysis, DOE has evaluated compliance strategies for Moab site ground water. Table 2–28 summarizes the compliance strategy selection process for the Moab site, which is based on the current understanding of the site and cleanup objectives.

The PEIS framework, as presented in Figure 2–40, and the site-specific conditions of the Moab site presented in Chapter 3.0 indicate that a "no remediation" compliance strategy and the application of supplemental standards to ground water is appropriate for protection of human health. However it may not be protective of the environment (i.e., endangered species). Therefore, active remediation is proposed for both the on-site and off-site surface disposal alternatives until natural processes have reduced ground water contaminant concentrations to acceptable risk levels for discharge to surface water.

Section 2.3.2 discusses proposed active remediation approaches that may be implemented to meet the cleanup and long-term protection requirements, independent of surface reclamation. The final determination of the most appropriate technologies and method for ground water treatment would require a more detailed characterization and engineering analysis.

Table 2–28. Summary of Compliance Strategy Selection Process

Box (Figure 2–40)	Action or Question	Result or Decision
1	Characterize plume and hydrological conditions.	The most recent conceptual model of the site is described in the SOWP (DOE 2003b) based on characterization activities conducted by DOE in 2002 and 2003. **Move to Box 2.**
2	Is ground water contamination present in excess of 40 CFR 192 MCLs or background concentrations?	**Yes:** Maximum ground water concentrations of arsenic, cadmium, molybdenum, nitrate, radium, selenium, uranium, and gross alpha exceed the 40 CFR 192 MCLs or Safe Drinking Water Act standards at one or more monitoring points. Levels of other constituents such as ammonia and sulfate are elevated compared with background and exceed risk-based concentrations. **Move to Box 4.**
4	Does contaminated ground water qualify for supplemental standards due to a classification of limited-use ground water?	**Yes:** The uppermost aquifer is predominantly composed of brine with concentrations of TDS in excess of 10,000 mg/L, which meets one of the criteria for limited-use ground water (40 CFR 192 and EPA 1988). EPA (1988) also indicates that "the entire ground-water unit being classified does not necessarily have to meet Class III [limited-use] untreatable criteria, but a major volume would." The major volume of the uppermost aquifer meets limited-use criteria. **Move to Box 5.**
5	Are human health and environmental risks of applying supplemental standards acceptable?	<u>Human Health Risks</u>: **Yes** Ground water is not reasonably considered to be a potential drinking water source because of its limited-use designation, and this use of water does not need to be considered further. Initial human health risk assessment results indicate that there are no unacceptable human health risks associated with uses of ground water other than drinking water (e.g., irrigation) and probable uses of hydraulically connected surface water (mainly recreational use). Therefore, protection of human health does not require any cleanup of ground water. For human health, no remediation required. Apply supplemental standards. **Move to Box 7.** (Note: Remainder of compliance strategy selection is focused on environmental risks.) <u>Environmental Risks:</u> **No** Toxicity tests conducted on fish using site-influenced ground water and surface water indicate that there is a potential for adverse effects to aquatic life (USGS 2002). Federal criteria for protection of aquatic life have been exceeded for ammonia. Concentrations of other constituents in surface water are elevated above background levels (e.g., uranium, sulfate). **Move to Box 6.**
6	Does contaminated ground water qualify for ACLs based on acceptable environmental risks and other factors?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 8.**
8	Does contaminated ground water qualify for supplemental standards due to excessive environmental harm from remediation?	**No: Move to Box 10.**

Table 2–28. Summary of Compliance Strategy Selection Process (continued)

Box (Figure 2–40)	Action or Question	Result or Decision
10	Would natural flushing result in compliance with MCLs, background concentrations, or ACLs within 100 years?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 13.**
13	Would natural flushing and active ground water remediation result in compliance with MCLs, background concentrations, or ACLs within 100 years?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 15.**
15	Would active ground water remediation methods result in compliance with background concentrations, MCLs, or ACLs?	**Yes:** Active remediation of ground water to control discharge to surface water can achieve surface water remediation goals until natural processes have reduced ground water concentrations to acceptable levels for discharge to surface water. **Move to Box 16.**
16	Perform active ground water remediation.	This is the compliance strategy identified by the PEIS framework.

2.3.1.4 *Initial and Interim Actions Related to the Proposed Action*

DOE, upon accepting responsibility for the Moab site, initiated consultations with USF&WS. On the basis of these consultations, and after reviewing historical surface water quality studies and data, DOE and USF&WS agreed that an elevated concentration of site-related ground water contaminants (primarily ammonia) reaching the Colorado River posed immediate risk to endangered fish and designated critical habitat.

On April 30, 2002, USF&WS concurred with DOE's decision to implement an initial action, followed by an interim action. The goal of the initial action was to dilute ammonia concentrations at the ground water–surface water interface in areas that presented the greatest potential for fish to be present, when backwater habitat has developed. It was estimated that backwater habitat would most likely be present from June through August at flows of 5,000 to 15,000 cfs. The action focused on the segment of the Colorado River from Moab Wash extending approximately 800 ft downriver, which contributes the highest concentrations of contaminants to the river. The system was designed to withdraw fresh water upstream of the site and pump it through a distribution system to backwater areas. Because of low flows, the system was not installed in 2003. The system was installed and tested in 2004, but because of low river flows caused by a continuing drought, the targeted backwater areas never held water, and the system could not be fully implemented.

The goal of the interim action is to extract contaminated ground water near the Colorado River, thereby reducing the amount of contamination reaching the river. DOE funded, designed, and implemented the system (Phase I) in 2003, which included 10 extraction wells aligned parallel to the Colorado River. The system is designed to withdraw ground water at the rate of approximately 30 gpm and pump it to an evaporation pond on top of the existing tailings pile. On April 4, 2004, USF&WS concurred with DOE's decision to construct a land-applied sprinkler system designed to increase evaporation rates. The system was installed in the existing evaporation pond area. In July 2004, DOE installed an additional 10 extraction wells (Phase II) near the first 10 wells to increase the rate of ground water extraction and to test the effects of freshwater injection on surface water concentrations. If the interim actions are successful, a reduction in contaminant concentrations in surface water could be observed significantly sooner than the 10-year maximum time frame predicted under the proposed action.

2.3.2 Proposed Ground Water Action

This section presents the potential ground water actions for both the on-site and off-site tailings disposal alternatives and provides the basis for assessing the impacts of these actions. This section also discusses ground water remediation objectives. Section 2.3.2.1 discusses ground water remediation options. Section 2.3.2.2 discusses time frames for implementation (i.e., pre-remediation period) of active remediation. Section 2.3.2.3 discusses construction and operational requirements. Section 2.3.2.4 discusses the active remediation target goals and time frames for remediation and compares the proposed ground water action to the No Action alternative.

The focus of active remediation would be on preventing ground water discharge to potentially sensitive surface water areas, as opposed to accelerating mass removal from the aquifer, though it is expected that the remediation should enhance the cleanup process. DOE's proposed action for ground water at the Moab site would be to design and implement an active remediation system and also apply ground water supplemental standards. These actions would be in addition to the initial and interim actions (described above) that have already been implemented. Ground water remediation would be implemented under both the on-site and off-site tailings disposal alternatives. It would be designed to intercept contaminated ground water that is currently discharging into the nearshore area of the Colorado River, which is designated critical habitat for endangered fish species. The proposed action would, at a minimum, meet the protective surface water criteria. It is possible that effects of the interim action and the proposed action may achieve background surface water quality conditions in less than the estimated 10 years after the ROD. The system would be operated until ground water contaminant concentrations have decreased to levels that would no longer present a risk to aquatic species. The duration of active remediation is predicted to be 75 years for the off-site disposal alternative and 80 years for the on-site disposal alternative (DOE 2003b).

Because selection and design of the actual extraction and treatment system have not yet begun, the proposed action cannot be described precisely. Therefore, the following descriptions address the scope of ground water extraction, treatment, and associated effluent discharge alternatives as if the remediation action were the one with the greatest potential for impact. In this way, DOE intends to bound the range of potential forms the proposed action could take and, consequently, the range of potential impacts from their implementation. These estimates are based on experience at other UMTRCA sites. Estimates based on those sites have been scaled up to accommodate the larger scope of the Moab site remediation. Where appropriate, distinctions are made between the construction/implementation phase of the proposed action and the operation/maintenance phase, because the scope, activities, and potential impacts from these two distinct periods would be substantially different.

2.3.2.1 Ground Water Remediation Options

Potential technologies for ground water treatment were prescreened to determine which remediation methods would be most feasible (DOE 2003b). In situ as well as ex situ methods were considered.

Active ground water remediation would be accomplished using one of, or a combination of, the options described below. All proposed remediation options would occur within the area of historical millsite activities and areas requiring surface remediation. Figure 2–41 shows the area of proposed ground water remediation.

Remediation would include the following options:

- Ground water extraction, treatment, and disposal
- Ground water extraction and deep well injection (without treatment)
- In situ ground water treatment
- Clean water application

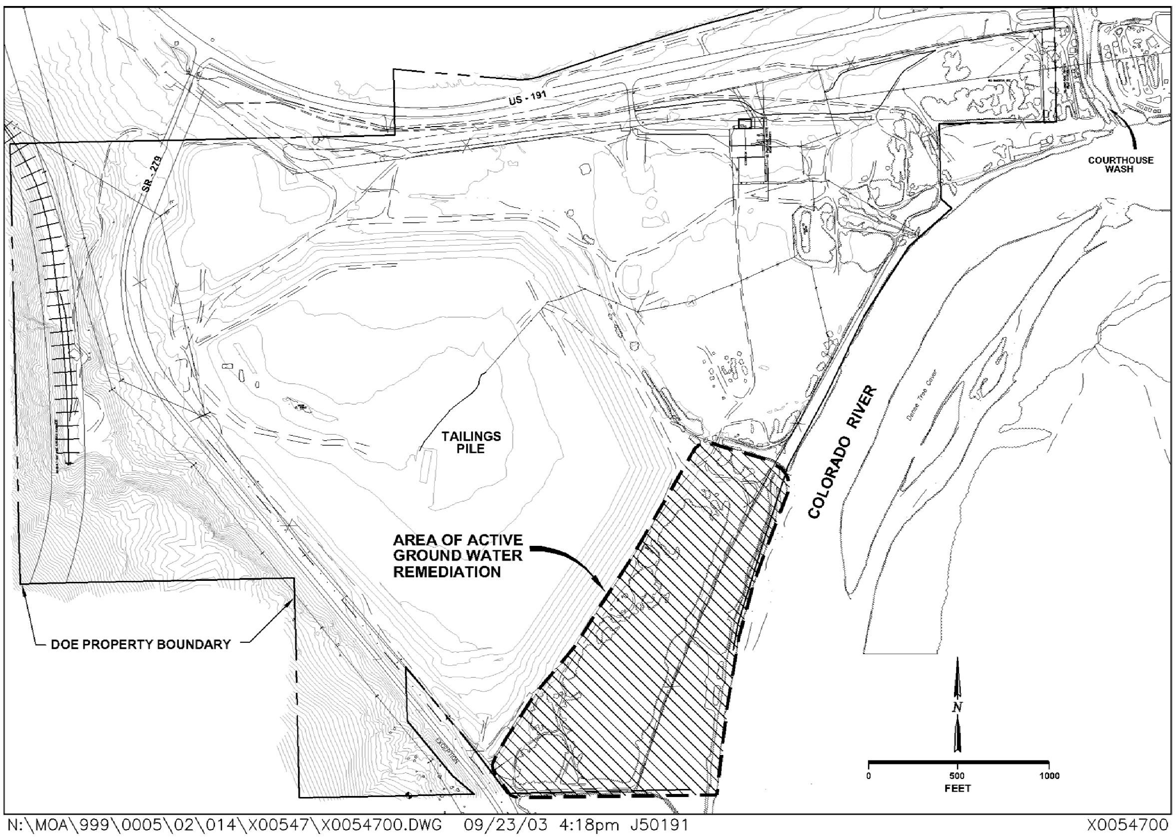

Figure 2–41. Area of Proposed Active Ground Water Remediation

Ground Water Extraction, Treatment, and Disposal

Ground Water Extraction: The two proposed methods for extracting contaminated ground water are extraction wells or interception trenches.

If extraction wells were used, between 50 and 150 wells would be installed to depths of up to 50 ft using conventional drilling equipment. This design would allow for extracting up to 150 gpm of contaminated ground water. The water would be pumped from the wells to a treatment collection point (e.g., evaporation pond) via subsurface piping. The system would be installed between the current tailings pile location and the Colorado River to intercept the plume before it discharged to the river and would require up to 50 acres of land for the duration of ground water remediation. The proposed locations (Figure 2–41) are within the area of historical site disturbances and areas requiring remediation of contaminated soils. It is expected that the system would be installed after any remediation of surface soils required in these areas. It is possible that some extraction wells would need to be installed adjacent to the river in areas northeast of the tailings pile in the vicinity of the old millsite.

If shallow trenches were used, they would be constructed to intercept shallow ground water, which would be piped via shallow subsurface piping to a collection point for treatment (e.g., evaporation pond). This design would allow for extracting up to 150 gpm of contaminated ground water. It is estimated that the system would require from 1,500 to 2,000 lineal ft of trenches and could affect up to 50 acres of land for the duration of ground water remediation. The proposed locations are within the area of historical site disturbances, and areas requiring remediation of contaminated soils.

Treatment Options: DOE has screened potential treatment technologies that would be applicable for treatment of ammonia and other contaminants of concern (DOE 2003b). The treatment options and technologies described below are meant to bound the range of viable possibilities. All treatment options would require construction of infrastructure. The level of treatment would depend largely on the selected method of effluent discharge. Therefore, specific treatment goals could not be established until the specific discharge method(s) were selected. The treatment goals would have to consider risk analysis and regulatory requirements.

Additional testing, characterization, or pilot studies may be required before the optimum system could be selected and designed. This level of design would be developed in the remedial action mentioned in Section 2.3.1, following publication of the ROD. The SOWP (DOE 2003b) presents more detailed descriptions of the processes and discusses the screening process for the following treatment options.

- Standard evaporation
- Enhanced evaporation
- Distillation
- Ammonia stripping
- Ammonia recovery
- Chemical oxidation
- Zero-valent iron
- Ion exchange
- Membrane separation
- Sulfate coagulation

Because evaporation is a primary treatment consideration and is also considered a disposal option, it is included in more detail. Evaporation treats extracted ground water by allowing the water to evaporate due to the dry conditions of the site and warm temperatures during part of the year. Influent rates to the ponds would match the rate of natural evaporation. Nonvolatile contaminants would be contained and allowed to concentrate, which would require provisions for disposal of the accumulated solids. Evaporation could also be used to treat concentrated wastewater from treatment processes such as distillation and ion-exchange that produce a wastewater stream. Passive evaporation would not require any mixing after disposal in the ponds. If it were determined that concentrations would present a risk to avian or terrestrial species, a wildlife management plan would be submitted to USF&WS, as further discussed in Appendix A1 (the Biological Assessment).

Solar evaporation would consist of putting the water into large, double-lined ponds built into the floodplain and designed to withstand a 100-year flood. Without enhanced methods, the pond or ponds would need to be of sufficient size that evaporation rates could keep up with extraction rates and complete remediation in a reasonable time frame. Pond areas could range up to 40 acres and include a total of 60 acres of land that would need to be disturbed. This would also require some type of small support facility. Devices such as spray nozzles could enhance evaporation rates considerably.

Disposal Options: If ground water were treated by a method other than evaporation, the treated water would require disposal by one of the following methods:

- Discharge to surface water
- Shallow injection
- Deep well injection

The Colorado River is a boundary to the Moab site, and it would be the natural repository of the site ground water if effluent were discharged to surface water. Because of water quality standards and designation as critical habitat for endangered fish, it is likely that this option would require extensive water treatment for all contaminants of concern. If discharge to the river was considered a viable alternative for dealing with treatment effluent, appropriate permits would need to be obtained from the State, and compliance with conditions such as discharge rates and effluent composition would be required.

If shallow injection were selected, injection wells would be used to return the treated ground water directly back into the alluvial aquifer. Treated ground water could potentially be used to recharge the aquifer at different points to allow manipulation of hydraulic gradients. This could facilitate extraction of the lower quality water and accelerate removal of the contaminant source. This option would require treatment of ammonia.

If deep well injection were selected, treated ground water would be disposed of by deep well injection into the Leadville Formation, Paradox Formation, or deep brine aquifer. Ground water hydrology beneath the site includes a deep salt formation called the Paradox Formation overlain by a deep aquifer with a high salt concentration (brine water). This method would likely require an underground injection control permit from the State of Utah.

<u>Ground Water Extraction and Deep Well Injection (without treatment)</u>

If this option were selected, ground water would be extracted using a system and infrastructure similar to that described above, and untreated water would be pumped into a geologically isolated zone. This option would likely require an underground injection control permit from the State of Utah and concurrence from NRC.

<u>In Situ Remediation</u>

If this option were selected, it would include some form of bioremediation, including phytoremediation (use of deep-rooted plants that extract certain contaminants from ground water through root uptake). This option would require minimal infrastructure and could require state or federal permits, depending on the method of bioremediation.

Clean Water Application

Another aspect of the active remediation system could involve some form of application of clean water to dilute ammonia concentrations in the backwater areas along the Colorado River that may have potentially suitable habitat for endangered fish. This would likely take either or both of two configurations. The first configuration would consist of diverting uncontaminated water from the Colorado River through a screened intake at the nearest location just upstream of Moab Wash. A water delivery system consisting of a pump and aboveground piping would redistribute the water to the backwater areas along a section of the sandbar of up to 1,200 ft beginning just south of Moab Wash. Flow meters and valves would be used to measure and control the rate of upstream river water released at each distribution point to minimize turbidity and velocities. The components and operation would be similar to the 1,360-gpm system originally planned as an initial action for the sandbar area adjacent to the site (DOE 2002b) or some alternative system design.

A variation of the clean water application could consist of using injection wells or an infiltration trench to deliver uncontaminated river water indirectly to the backwater areas. For this second configuration, clean water would be collected from the Colorado River and pumped to the site water storage ponds to control suspended sediment and prevent system clogging. The storage pond water would then be introduced to the shallow ground water system by a series of injection wells or infiltration trenches located along the bank adjacent to the backwater areas. The clean water would enter the backwater areas by bank discharge of ground water to provide dilution of ammonia concentrations. This clean water application system could also be combined with the extraction wells discussed earlier to control drawdown and minimize the potential for brine upconing. For this case, up to 150 gpm of uncontaminated river water would be needed to balance the amount of plume water extracted.

2.3.2.2 Implementation of Ground Water Remediation

DOE estimates that design, procurement, testing, construction, and implementation of an active ground water remediation system would be complete within 5 years of issuance of the ROD (Figure 2–42). Design criteria and specifications would depend upon whether the on-site or off-site alternative was selected for tailings disposal.

Following the start of system operation, DOE estimates that as much as an additional 5 years (Figure 2–42) could be required to reduce concentrations of contaminants in the surface water to levels that are protective of aquatic species in the Colorado River, if protective levels were not already achieved as a result of interim actions. However, it is possible that considerably less time could be required to reach protective levels. The period of construction and implementation is considered the pre-remediation period.

2.3.2.3 Construction and Operational Requirements

Number of Workers and Duration of Work

The greatest numbers of workers would be required during the initial construction of the remediation system. Construction of the system would include installing an extraction system and constructing a treatment system. Construction of a distillation system would probably be the most labor-intensive water treatment option and require the greatest diversity of workers because

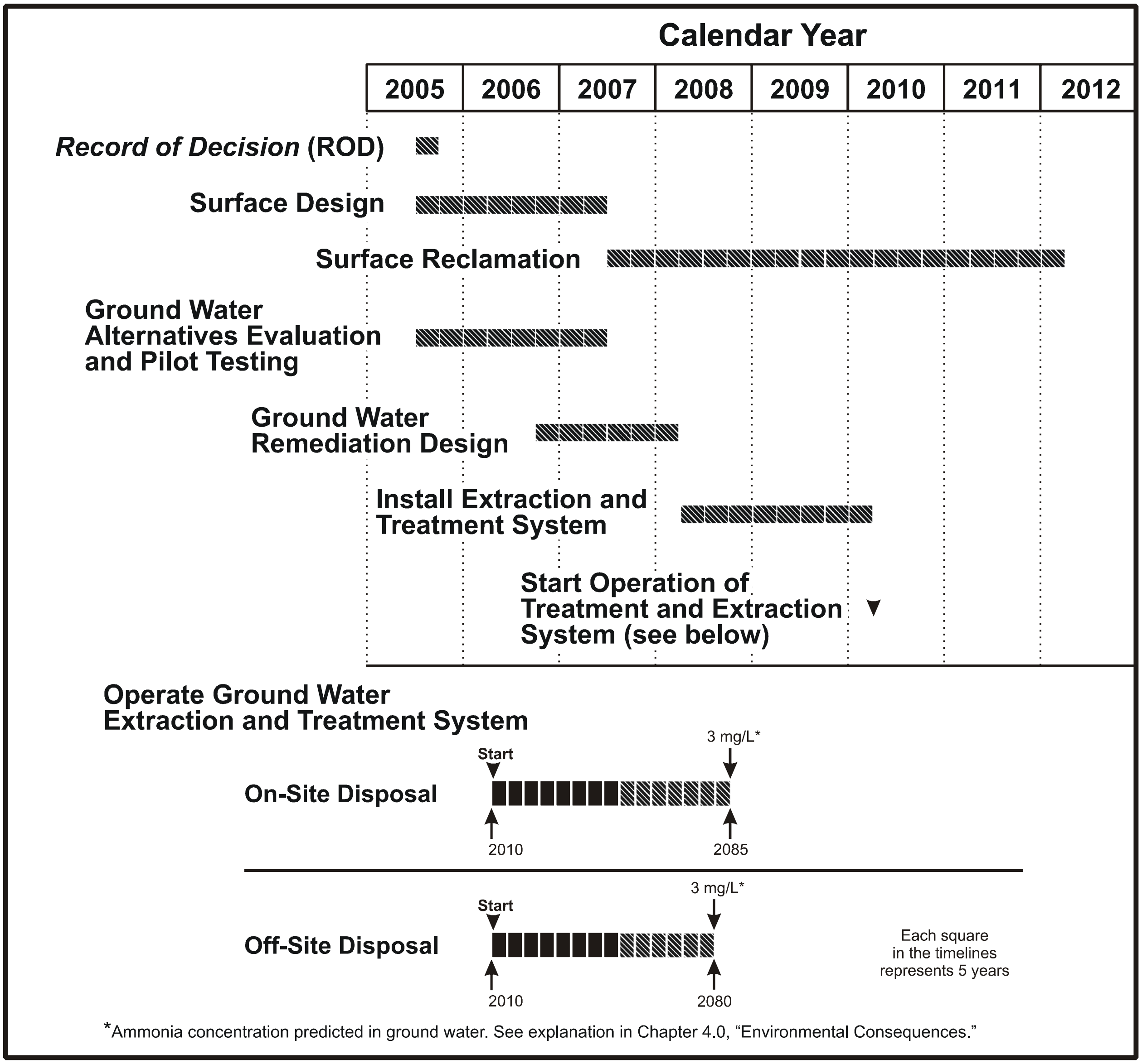

Figure 2–42. Estimated Ground Water Remediation Schedule

of the complexity of the system. After the system construction was complete, routine operation and periodic maintenance and monitoring would be required until remediation goals were met. If the treatment process produced a solid waste stream, such as a sludge produced from residual brines generated during distillation, transportation to an off-site disposal facility could be required.

Required workers would include construction workers, operators, engineers, electricians, plumbers, and administrative support.

- Number of workers for construction: 25 to 50; duration: 12 months
- Number of workers for operation: 2 to 6; duration: 80 years (on-site disposal) and 75 years (off-site disposal)

If the initial action discussed in Section 2.3.1.4 were needed to dilute river water during installation of the active system, it could be started almost immediately. Construction of the active system would not start until surface remediation was completed in the location where the system would be installed.

Number and Types of Equipment

Installation of an extraction system would require either conventional drill rigs for the wells or heavy equipment (e.g., backhoes) for construction of trenches. If ground water treatment were required, a treatment plant would need to be constructed with infrastructure to meet the operational requirements of the treatment system. The technology requiring the greatest amount of equipment for construction would be installation of an evaporation pond system because of the large amount of excavation required. Typical construction and earth-moving equipment would be required. Additional considerations include air emission controls, holding tanks, water lines, electrical lines, chemical storage areas, and pumps. After construction, the only equipment required for continued operations would likely be pickup trucks.

Equipment estimates are based on construction of an evaporation pond at a similar UMTRCA site near Tuba City, Arizona. Table 2–29 provides estimated equipment requirements for a scaled-up 40-acre evaporation pond at the Moab site to manage the estimated 150-gpm ground water extraction rate.

Table 2–29. Estimated Equipment Requirements

Equipment	No. of Equipment
Tractor	2
Drill rig for wells	1
Trackhoe for trenches	1
Backhoe	2
Grader	2
Front-end loader	1
End dump truck	1
Water truck	2
Scrapers (21 yd^3)	4
Dozer	2
Sheepfoot compactors	2
Smooth drum roller	1
Pickup	2
Skidsteer	1

Wastes Generated and Waste Management Requirements

Depending on the way extracted ground water would be treated and managed, different waste streams could be generated. Some of these waste streams would require some form of additional management, whereas others would be lost naturally to the atmosphere or subsurface. For example, if evaporation were the selected method for addressing ground water remediation, contaminated ground water would be discharged to an evaporation pond. Some constituents, such as ammonia, would volatilize to the atmosphere in the form of air emissions. The water in the pond would evaporate, and dissolved solids would eventually accumulate and be left as a residual sludge that would require waste management. Depending on combinations of technologies selected, different combinations of wastes would be generated, requiring different management techniques. Minimization of liquid wastes would result in more solids to manage. Different treatment options would result in varying amounts of secondary solids.

Regardless of the active method selected, is it assumed that any remediation system would need to accommodate a feed rate of 150 gpm of contaminated water. The average influent stream water composition would be roughly 1,000 mg/L ammonia, 7 mg/L uranium, and 20,000 mg/L TDS. Because ammonia is volatile, its release could result in air emissions; the dissolved solids would end up in solid form by removal of water through the remediation process.

Air Emissions. Operation of an evaporation pond, particularly spray evaporation, or an ammonia-stripping treatment technology would probably be the alternatives with the highest air emissions. Emission control devices on treatment plants could probably control emissions for some treatment methods. Residuals from these control systems would then require subsequent disposal. Control of emissions from an evaporation pond would not be feasible. However, the pond could be designed and operated to minimize impacts on surrounding areas.

Water Effluents. It is assumed that the same volume of extracted ground water would need to be handled regardless of the remedial system selected. However, resulting water effluents from that system would be of varying quality and would require different methods of handling. For deep injection and evaporation, extracted ground water would go directly to its final disposal with no intermediate steps. Water effluents produced as a result of some treatment process could require no special handling, as in the case of treated water that is produced through distillation, or may require some additional management method (such as the residual brine from distillation). Additional studies could be required if water effluents would be used for land application so that soils were not adversely affected.

Waste Solids. Solids generated from ground water remediation would mostly include sludges derived from processes employing precipitation and evaporation, or RRM or filters used in flow-through media processes. Both distillation and evaporation would concentrate dissolved solids and would probably produce the most concentrated waste solids. Larger volumes of lower-concentration wastes could be produced by use of flow-through processes. An estimated 6,600 tons per year of RRM waste would be generated, assuming all of the 20,000 mg/L TDS in the treatment stream would be recovered at a treatment capacity of 150 gpm. These RRM wastes would need to be disposed of at a low-level waste disposal site or at an UMTRCA disposal cell.

<u>Land Use Requirements</u>

The greatest requirements for land use would probably be associated with the evaporation alternative. A sufficiently large pond would need to be constructed to achieve evaporation rates that could keep up with extraction rates and complete remediation in a reasonable time frame. Estimated pond areas range up to 40 acres, and a total of 60 acres of land would need to be disturbed. Any active remediation alternative would require some type of support facility, but this would be expected to be minor and would probably be located in already disturbed areas. If land application of treated water were selected as the preferred effluent disposal alternative, sufficient land would need to be reserved for this purpose with a delivery system installed to transport and deliver the effluents (piping and sprinkler heads). A similar land farming alternative for an UMTRCA site in Monument Valley, Arizona, was estimated to require approximately 30 acres to handle 80 gpm of water; extraction rates at the Moab site are estimated to be a maximum of 150 gpm. If treated effluents resulted in a proportional volume of water requiring land application, land use requirements would probably be less than 60 acres. However, unlike under the evaporation alternative, this land could serve other beneficial purposes.

Natural Resource Requirements

Power consumption needs for a distillation unit would be the highest required for ground water remediation. Based on operation of a distillation unit at Tuba City, Arizona, an UMTRCA site similar to the Moab site, it is estimated that the maximum electrical power demand would be approximately 600 kVA. The capacity of the existing distribution system circuit at the Moab site would support this demand. An estimate of diesel fuel consumption for construction of an evaporation pond is shown in Table 2–30.

Table 2–30. Estimated Diesel Fuel Consumption for Evaporation Pond Construction (12-month period)

Equipment Type	Number of Equipment Total Project	Consumption (gallons per hour)	Consumption (gallons per year per piece)
CAT Ag. tractor (Challenger 55)	2	9	54,000
CAT 420D backhoe	2	3	18,000
CAT 140H grader	2	6	36,000
CAT 9880G front-end loader	1	13	39,000
12 yd^3 end dump	1	3	9,000
4000 gal. capacity water truck	2	3	18,000
CAT 621G 21 yd^3 scrapers	4	11	132,000
CAT D8R dozer	2	9	54,000
CAT 825G soil compactors	2	15	90,000
CAT CS533D drum roller	1	4	12,000
Pickup truck	2	1	6,000
CAT 248 skidsteer loader	1	3	9,000
Total Diesel Fuel Consumption			477,000

Construction Materials (e.g., building materials, piping, pumps)

For an evaporation pond for ground water remediation, construction materials for a berm would come from clean, on-site materials. If the decision were made to implement some form of interim action in the potential habitat areas of the river before the active remediation system was fully operational, water could be extracted using the existing pumping system upgradient of the site and discharged to the potential habitat areas adjacent to the site. If application of fresh river water were implemented as an interim measure, DOE estimates that 50 to 500 gpm of river water would be withdrawn and used for this purpose. Almost all the water withdrawn would be returned to the river in fish habitat areas. The interim action would continue only until active ground water remediation began–that is, for a period of 4 to 5 years or less after issuance of the ROD.

2.3.2.4 Active Remediation Operations

The active remediation system would begin to extract and treat ground water within 10 years of the ROD and would continue for 75 to 80 years (depending on whether an off-site or on-site surface remediation alternative were implemented) to maintain surface water quality goals. This is the predicted time to allow natural processes to diminish the contaminant sources to the point that maximum ground water concentrations adjacent to the river meet the target goals (Figure 2–43). Contaminant concentrations in the ground water are thus predicted to be at acceptable risk levels prior to entry into the Colorado River within 10 years of the ROD. Active remediation would cease only after ground water and surface water monitoring confirmed that long-term remediation goals were achieved. The 3-mg/L target goal is a reasonably conservative ground water goal that should result in ammonia compliance in surface water given the uncertainties involved in predicting contaminant behavior. These uncertainties associated with the success of active remediation are discussed further in Section 2.3.3. Ground water and surface water would be monitored for any alternative that is selected to assess the progress of the active remediation system in achieving long-term remediation objectives and verifying predicted concentrations.

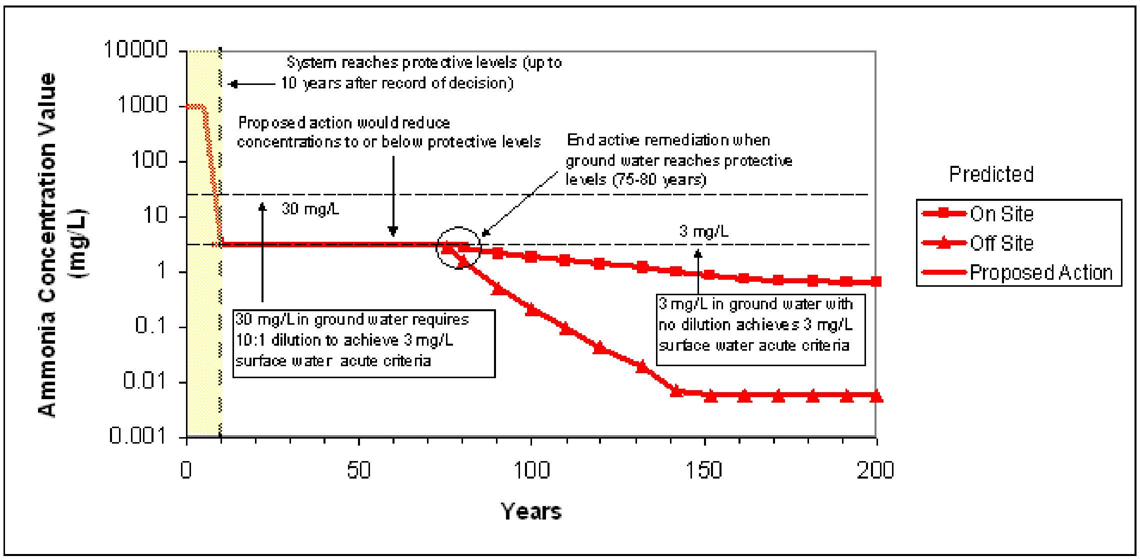

Figure 2–43. Predicted Maximum Ammonia Concentrations in Ground Water for Active Remediation

Table 2–31 summarizes the predicted schedule for meeting the target goal of 3-mg/L *in ground water* based on ground water modeling results (using base case assumptions). Ground water modeling results indicate that ground water ammonia concentrations would slowly decline through time under all remedial scenarios and under the No Action alternative. The on-site disposal alternative is predicted to meet the 3-mg/L target goal in approximately 80 years. The off-site disposal alternative is predicted to meet the 3-mg/L target goal in approximately 75 years. According to modeling results for the on-site disposal alternative, the lowest achievable ground water concentrations of ammonia would be less than 0.7 mg/L in 200 years at steady-state. For the off-site disposal alternative, the ground water concentrations of ammonia would reach the most stringent calculated chronic ammonia State of Utah standard for the site (0.2 mg/L) in 100 years and eventually decline to background levels in 150 years.

Table 2–31. Schedule for Meeting Ground Water Target Remediation Goals

Post-ROD Project Phase	Remediation Target Goals Achieved	
	On-site Alternative	Off-site Alternatives
Pre-remediation (within 10 years of the ROD)	No	No
Remediation—on-site disposal (within 80 years of the ROD)	Yes	NA
Remediation—off-site disposal (within 75 years of the ROD)	NA	Yes
Post-remediation	Yes	Yes

Higher ground water concentrations, such as those resulting from the No Action alternative, could comply with surface water standards, albeit at a lower confidence level.

The lowest concentration achievable under the No Action alternative is 6 mg/L; therefore, this alternative would not meet the 3-mg/L target goal. Figure 2–44 shows the ammonia concentrations over time for the No Action alternative.

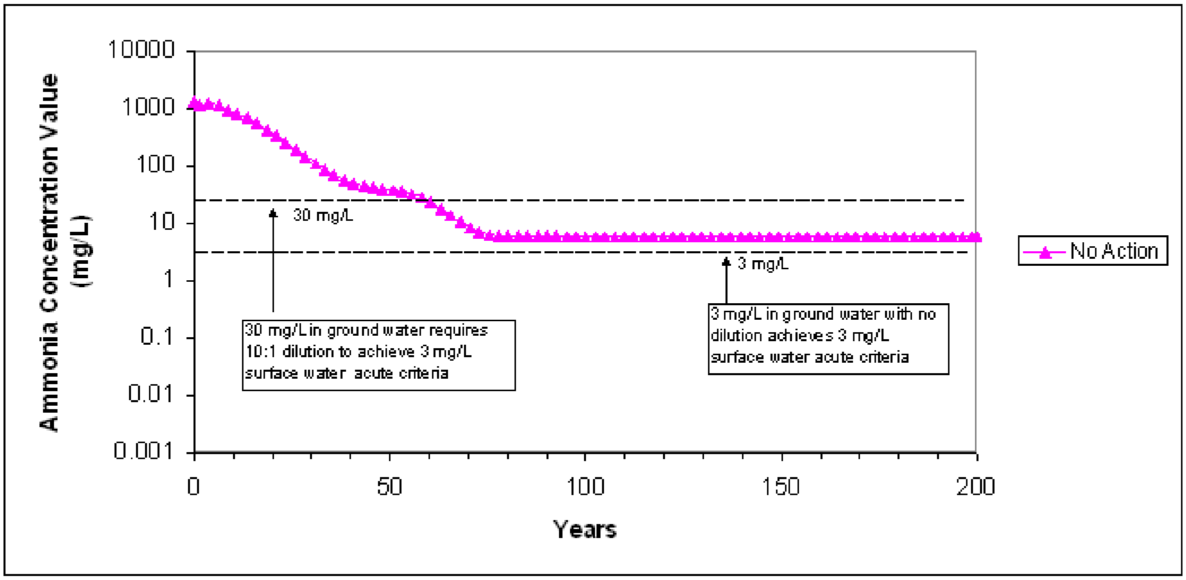

Figure 2–44. Predicted Maximum Ammonia Concentrations in Ground Water for No Action

2.3.3 Uncertainties

DOE does not have a quantitative estimate of uncertainty associated with modeling predictions estimating the time for ground water concentrations to reach target goals that are protective of aquatic species. The uncertainties can be grouped into the following general categories:

- Future changes in the status of threatened and endangered species.
- Future changes in AWQC.
- Uncertainties in concentrations predicted by the ground water model.

- Uncertainties in the time to achieve the target goal predicted by the ground water model.
- Change in concentrations of contaminants associated with ground water discharge to surface water (i.e., application of a dilution factor).

This analysis of uncertainties focuses on the goal of achieving concentrations of contaminants in the river that are protective of threatened and endangered fish species. According to the recovery plan for the Colorado pikeminnow (USF&WS 2002), downlisting could be achieved by 2006 and delisting by 2013. The razorback sucker could be delisted by as early as 2023 (USF&WS 2002). At that time, protection of threatened and endangered fish and critical habitat could have less significance, and less conservative remediation objectives could be applicable. Conversely, ambient water quality standards (federal or state) could be revised that affect target remediation goals.

Sections 7.3, 7.6, and 7.8 of the SOWP (DOE 2003b) discuss the sensitivity of the ground water flow and transport model to specific modeling input parameters as well as modeling uncertainty. Specifically, transport parameters (e.g., tailings seepage concentration and the natural degradation of ammonia in the subsurface) were found to have a much greater impact on predicted concentrations than did flow parameters (e.g., hydraulic conductivity and effective porosity). The sensitivity analysis performed indicates that perturbing the key transport parameters from the calibrated values could result in either significantly higher or significantly lower contaminant concentrations in the ground water adjacent to the river; it did not indicate the probability or likelihood of any one outcome.

The variables affecting prediction accuracy are many, and the system of contaminant transport and the interaction between ground water and surface are complex, largely due to the dynamic nature of river stage and backwater area morphology. To compensate for the inherent uncertainties, DOE has assumed a conservative protective water quality goal of meeting the lowest possible acute aquatic standard (based on the range of observed pH and temperature conditions in the river) in the ground water with no consideration of dilution.

<u>On-Site Disposal</u>

Model predictions, supported by the site-specific data, indicate that long-term ground water concentrations adjacent to the river (0.7 mg/L ammonia for the on-site disposal alternative) would be protective for acute and chronic exposure scenarios for all but the worst-case pH and temperature conditions without any consideration of dilution from the surface waters.

Because seepage from the tailings pile represents a long-term source of ground water loading, an on-site disposal decision could result in longer-term active ground water remediation; higher concentrations of residual ground water contamination also would be expected to remain at the conclusion of the remediation time period (see Figure 2–43). The longer operational time period would also result in a corresponding increase in operational costs of the system.

Some acceleration of cleanup could be realized under the on-site disposal alternative by focused ground water remediation of the legacy plume and the ammonia flux from the brine interface. However, after the legacy plume and ammonia flux from the brine interface were depleted, the continued presence of the tailings pile source would limit the degree to which concentrations could ultimately be reduced. Uncertainties associated with model predictions for the on-site disposal alternative involve both time required to meet steady-state conditions and the question of whether the target goals (i.e., concentrations) could be met.

Off-Site Disposal

Model predictions, supported by the site-specific data, indicate that long-term ground water concentrations adjacent to the river (background concentrations for the off-site disposal alternative) would be protective for acute and chronic exposure scenarios for all but the worst-case pH and temperature conditions without any consideration of dilution from the surface waters.

No Action Alternative

It is possible that the No Action alternative would meet the target goal considering the number of uncertainties involved. For example, a factor-of-2 decrease in the 6-mg/L ammonia concentration in ground water predicted at steady state would result in meeting the 3-mg/L target goal. A factor-of-2 decrease in predicted concentrations is within the lower range of uncertainty.

It is clear that if ground water concentrations comply with remediation objectives, surface water concentrations should comply as well. Therefore, on the basis of site-specific data and a study of the site conditions, DOE has a reasonable degree of confidence that protective conditions would be met and maintained both during the operation of the remedial action (75 to 80 years) and following achievement of water quality goals. Monitoring would confirm performance to meet target concentrations.

2.4 No Action Alternative

Although DOE would not remediate contaminated materials or ground water under this alternative, DOE would likely complete tasks necessary to secure the site to minimize the potential for accidents. For example, power would be turned off and equipment would be removed. This alternative is analyzed to provide a basis for comparison to the action alternatives and is required by NEPA regulations (40 CFR 1502.14[d]).

Under the No Action alternative, DOE would not remediate on-site surface contamination, which includes the existing tailings pile, contaminated materials and buildings, and unconsolidated soils. The existing tailings pile with its interim cover would not be capped and managed in accordance with 40 CFR 192 standards; this consequence of the No Action alternative would conflict with the requirements of the Floyd D. Spence Act. In addition, no site controls or activities to protect human health or the environment would be continued or implemented. Public access to the site would be unrestricted. All site activities, including operation and maintenance activities, would cease. Vicinity properties located close to the site and near the town of Moab, including residences, commercial and industrial properties, and vacant land, would also not be remediated.

Initial and interim ground water actions would not be continued or implemented. DOE would abandon all ongoing and planned activities designed to protect endangered species and prevent discharge of contaminated ground water to the Colorado River. No further media sampling or characterization of the site would take place.